

TITLE

The title should describe the experiment. It should be specific, professional, and scientific. Don't use a generic title like "Density Lab"; instead, you could use something like "Using Calculations to Solve for Density".

Example Title

Title: Using Calculations to Solve for Density

INTRODUCTION

This section introduces and gives some background on the topic being explored. It should include three main categories: the Problem, Background Information, and the Hypothesis.

Problem/Purpose/ Objective of the Experiment

The purpose is expressed clearly in only one or two sentences, including the main method used to accomplish the purpose.

Background Information

The background section should include research that needed to do in order to understand the experiment. Students may want to use outside resources such as notes, textbooks, reference books, scientific publications, and other high-quality sources. The background information should be as straightforward, clear, and concise as possible.

Hypothesis

A hypothesis is an educated prediction about what is expected to happen in the experiment based on background information. The hypothesis should be able to be written in a format with the words: "If...then...because..." and it should include the independent and dependent variables. Explain the reason that the hypothesis was chosen.

Some useful vocabulary terms include:

- The **independent variable** is a factor in the experiment that is changed on purpose.
- The **dependent variable** is a factor in the experiment that responds to the independent variable.
- The **control** includes all factors that remain the same throughout the experiment (the **constants**), but not the factor that changes (independent variable).
- Repeated **trials** are the number of times an experiment is repeated and is useful in validating data and checking precision.

An example of an introduction is given on the next page. The problem, background information, and hypothesis are labeled.

Example Introduction

Making calculations emphasizes analytic measurements, experimental technique, and problem solving in determining measurements. The purpose in this lab was to determine the densities of regular and irregular shaped objects.

The density of an object is calculated by dividing the mass of the object by the volume of the object. A triple beam balance was used to find the mass of all the objects in the experiment. To find the volume of the regular shaped objects, you must find the length, width, and height of the object and multiple these measurements to find the objects volume. To find the volume of the irregular shaped objects, you must use a graduated cylinder and measure the water level before and after the object is placed in the cylinder. The difference in these two numbers is the volume of the irregular shaped object. The SI unit for mass in this experiment was grams. The SI unit for volume in this experiment was cm^3 for regular shaped objects and mL for irregular shaped objects. The SI unit for density in this experiment was g/cm^3 for regular shaped objects and g/mL for irregular shaped objects.

I predict that if an object is heavy, then its density should be higher than water's (it should sink) and if an object is light, then its density should be lower than water's (it should float). I expect this result because mass is used to calculate density and I have seen many heavy objects sink in water.

Purpose

Background
Information

*(normally, outside
sources would be
included here)*

Hypothesis

SAFETY

This section should include information on hazardous substances, specific precautions to take, and safety equipment needed. Listen to safety information and directions presented during class and read any directions given before starting the lab. Ask the teacher if unsure about any safety information. Safety information should be summarized in as few sentences as possible.

Example Safety Information

- Wear goggles during this experiment. Goggles should be worn anytime heat, chemicals, or glassware are used.
- Tell the teacher about any accidents right away.

MATERIALS

Write a complete and accurate list of equipment and chemicals. Indicate how much of each material will be used in the experiment. Sketches of complex setups may also be included.

Example Materials List

- | | |
|-------------------------|--------------------------------|
| 1 – Triple Beam Balance | 1 – Graduated Cylinder, 100 mL |
| 1 – Ruler | 10 – Density Specimens |
| 1 – Calculator | 1 – Beaker, 500 mL |
| 1 – Container of Water | |

PROCEDURE

The procedure section includes the process of the experiment exactly as it was done in the laboratory. The procedure is written out step-wise in the form of a numbered list. It should include cleaning equipment, setting up equipment, taking measurements, and even cleaning up. Never use “I”, “we”, “you”, “me”, or other pronouns in a procedure. Focus on what should be done, not who is doing it.

Do not write any data, results, or observations (things that happened when the procedure was being carried out) in this section; only include the procedures carried out in lab. The section should not include doing calculations or writing a conclusion. A good rule of thumb for writing complete but concise experimental procedures is to include enough information so that others who read the report would be able to duplicate the experiment at a later date.

Example Stepwise Procedure

1. Clear the workstation. Have one person on the lab team get all of the materials for the workstation.
2. Separate the density specimens into regular shaped and irregular shaped objects.
3. Write down the name of each regular shaped object under object in a data table.
4. Write down the name of each irregular shaped object under object in a data table.
5. Find the mass of all regular shaped objects using the triple beam balance and record the mass in the data table using grams (g) as the SI unit.
6. Find the mass of all irregular shaped objects using the triple beam balance and record the mass in the data table using grams (g) as the SI unit.
7. Find the volume of all regular shaped objects using the ruler and record the volume in the data table using centimeters cubed (cm^3) as the SI unit.
8. Find the volume of all the irregular shaped objects using the water and the graduated cylinder and find the difference in water level before and after the object was placed in the graduated cylinder. Record the volume in the data table using milliliters (mL) as the SI unit.
9. Dry and place all density specimens back on the specimen tray.

10. Use the calculator to calculate the density of each regular shape and irregular shape object. Use g/cm^3 as the SI unit for all regular shaped objects and g/mL as the SI unit for all irregular shaped objects.
11. Now that the data table is complete, return all lab materials to the main counter and make sure the lab station is as clean as it was when starting the lab.
12. Create a bar graph showing the density specimen against the density. Use the graph given in the lab handout.
13. Begin analyzing data. Look to find which objects would float in water and which objects will sink in water.
14. Write any notes that will help in writing the conclusion to this lab.
15. Use this lab handout to help write the formal lab report

DATA AND RESULTS (ALSO KNOWN AS OBSERVATIONS)

This section should include observations from the experiment. Use tables, charts, and graphs whenever possible. Organize narrative observations (information written using sentences) in a neat and orderly form. Be sure to mention everything important that was seen, heard, smelled, or recorded. Include observations such as color, shape, mass (weight), length, volume, temperature, and smell. Data and results should be labeled clearly and include units. Be sure not to attempt to explain.

Suggestions

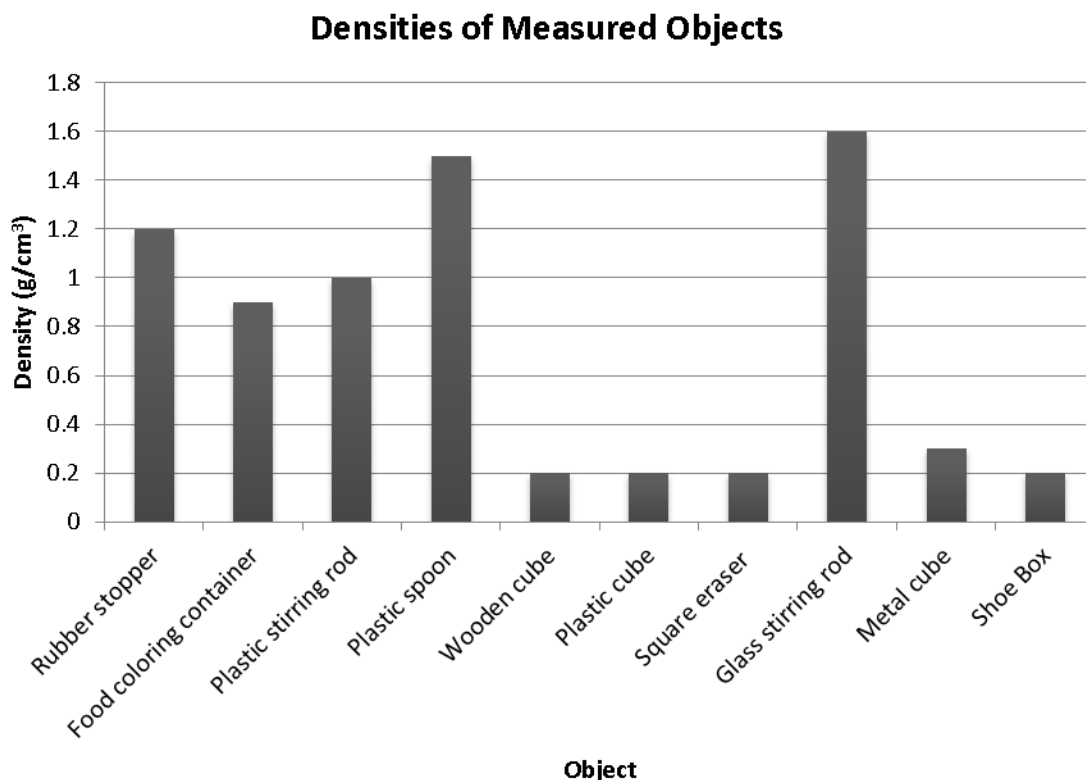
- Data consists of every raw, unmodified measurement taken during the experiment (and extra observations and notes).
- Results are a product of manipulating data. Examples are calculations and graphs.
- Graphs should be on graph paper, or done using a graphing program like MS Excel. Include proper features of a graph like titles and labels on axes. Graphs should be an appropriate size.
- Use a descriptive caption for each table, chart, and graph. For example “Weights and Densities of Metal Cylinders”.
- Make measurements using metric units (grams, meters, etc.) when possible.

Example Data and Results

Table of Densities of Objects

Object	Mass (g)	Volume	Density (g/cm³)
Rubber stopper (cylinder)	6	5 mL	1.2 g/mL
Food coloring container	8	9 mL	0.9 g/mL
Plastic stirring rod	9	9 mL	1 g/mL
Plastic spoon	9	6 mL	1.5 g/mL
Wooden cube	10	54 cm ³	0.2 g/cm ³
Plastic cube	11	54 cm ³	0.2 g/cm ³
Square eraser	13	72 cm ³	0.2 g/cm ³
Glass stirring rod	13	8 mL	1.6 g/mL
Metal cube	14	54 cm ³	0.3 g/cm ³
Shoe box	26	144 cm ³	0.2 g/cm ³

- 1 g/mL or 1g/cm³ is the density of water. The specimens below 1 will float in water and the specimens above 1 will sink in water



CONCLUSION

In 1-2 sentences, make a claim about the overall pattern or trend in the results. It should answer the lab's original purpose/question.

In paragraph form, explain the claim or claims. Use evidence to show the reader how the data and results support the conclusion and claims. Only repeat your observations if they are used as examples. Do not assume the reader can "connect the dots" himself or herself. Connect the dots for him or her. These are some questions that should be answered:

- What have you found? What patterns are in the data?
- How does your claim relate to your original purpose or question?
- How does your data support or reject your hypothesis?
- What do your results mean?
- How does your conclusion relate to the information you learned in class or background information you researched?
- What sources of error could have affected your results? In other words, what could have gone wrong and how would you fix that problem?

An example of a conclusion is given on the next page. The claim, explanation, sources of error, and ideas for future experiments are labeled.

Example Conclusion

In this lab, the densities of several regular and irregular shaped objects were calculated successfully. Based on the results, the original hypothesis was incorrect. Not all heavy objects have densities higher than water's density (1 g/cm^3) and not all light objects have densities lower than water's.

The claim
(and how it
relates to the
hypothesis)

The density equation was used to turn the objects' mass and volume into density. Since 1 g/mL or 1 g/cm^3 is the density of water, the specimens below 1 should float in water and the specimens above 1 should sink in water. If this is true, the hypothesis was incorrect. For example, the metal cube was heavy (14 g) but had a density of 0.3 g/cm^3 which is lower than water's density. It should float in water even though it is heavy. The glass stirring rod was also heavy (13 g), but its density was higher than water's so it should sink. The same conclusion could be made about the lighter objects. Some light objects, such as the food coloring container and wooden cube have densities lower than water and should float. Other objects, such as the rubber stopper and plastic spoon should sink because of their higher densities. The measurements of volume were very difficult because it was hard to get the object completely in the water. The irregularly shaped objects should have a bigger error in their densities as a result. If the density is close to 1 g/mL , they might float or sink because of the error.

Explanation
of the claim

Possible
sources of
error

Since the density calculation also includes volume, mass is not the only important measurement in predicting density. I conclude that the volume of the object was just as important as the mass in telling whether an object will float or sink in water. Since both variables (mass and volume) play a role in determining whether an object will float or sink in water, another experiment could show that even a very heavy object (like a metal boat) could float in water if its volume was also big enough.

Future
experiments/
real world
applications

REFERENCES

If outside sources have been cited, a reference list will be needed. Unless a different a format is specified, APA citations should be used. The APA citation guide is later in this document.

APPENDIX

Students may be asked to attach additional information to the end of lab. If there is a significant amount of extra data or calculations, it may be beneficial to put them into an appendix at the end of the report. Hand-written material, the original lab data sheet, additional charts and graphs, prior research,

calculations including work, answers to extra questions, and pre-lab assignments are all possible items to include in the appendix.